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(71) Applicants
Zahnradfabrik Friedrichshafen AG (FR Germany), Postf 2520, D—7990 Friedrichshafen 1, Federal Republic of Germany
(72) Inventors
Friedrich Schreiner,
Walter Müller
(74) Agents
M. J. Stephens and Co., Royal Building, 11 St. Andrews Cross, Plymouth PL1 2DS

(54) **Planetary change-speed gear**

(57) A change-speed gear unit suitable for automatic operation in a motor vehicle, comprises two first clutches (A, B) capable of actuation under load, a number of planetary gear sets (I, II, III), and a plurality of brakes (G, H, J) and second clutches (C, D, E). In operation, the two first clutches (A, B) are engageable alternately to shift the gear unit through a range of gear settings in each of which the operative drive line through the unit is determined by the brakes (G, H J) and second clutches (D, E) and passes through the engaged one of the first clutches (A, B), the overall arrangement being such that the brakes and second clutches needing to be engaged for the gear setting next required can be engaged in an unloaded condition whilst drive is transmitted through the operative drive line. Due to this arrangement only the first clutches (A, B) are required to be capable of actuation under load. By multiple utilisation of the gear unit components, a comparatively large number of gear settings can be provided with a relatively simple construction.

FIG. 1

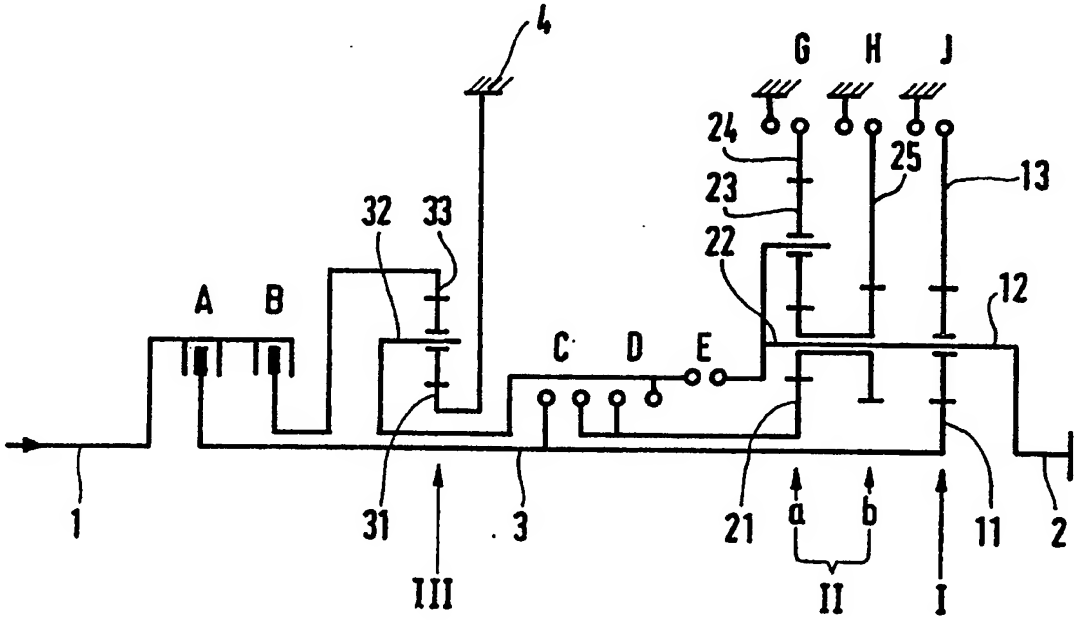

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FIG. 1

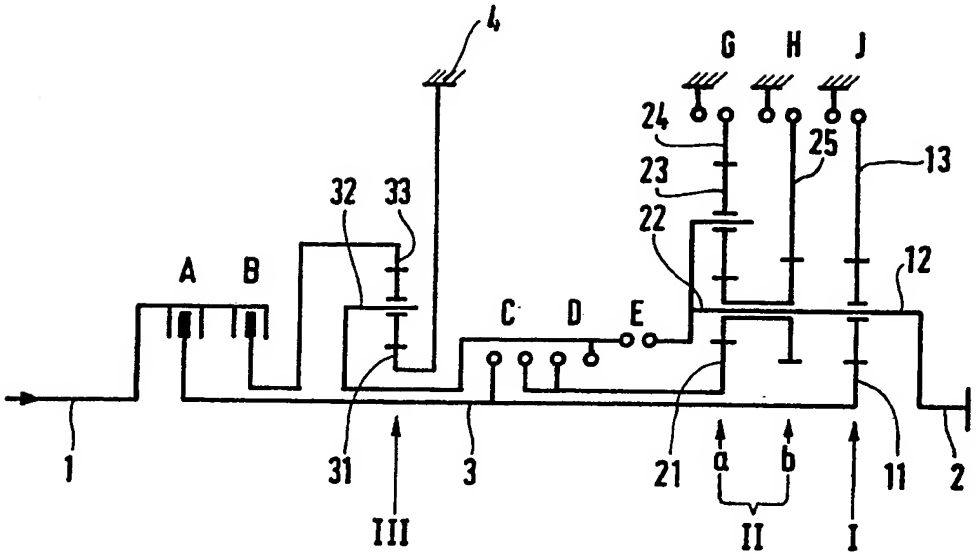

FIG. 2

	i	A	B	C	D	E	G	H	J
R.	6,0		o		o		o		
1.G	6,41		o	o	o				o
2.G	4,42	o							o
3.G	3,05		o		o			o	
4.G	2,10	o		o				o	
5.G	1,45		o			o			
6.G	1,0	o		o	o	o			

FIG. 3

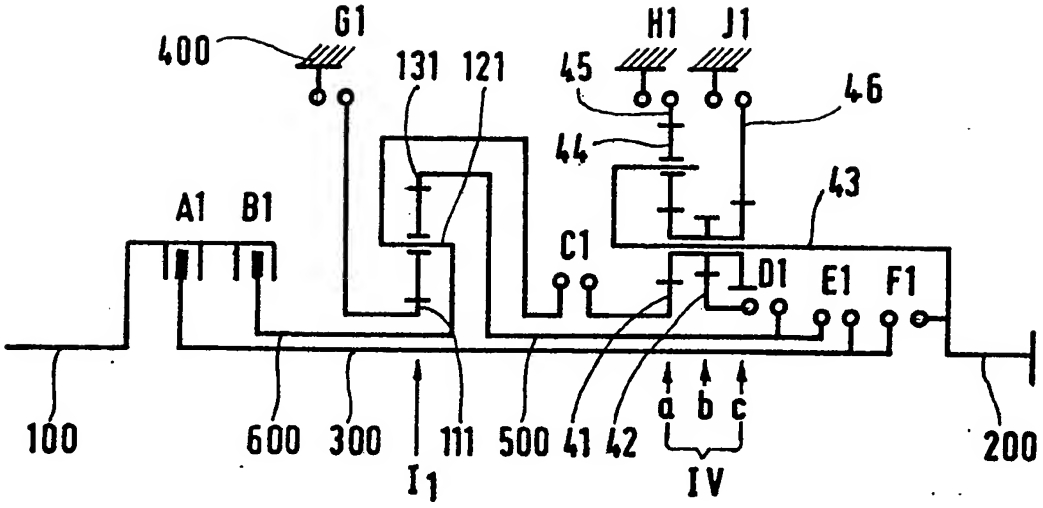

FIG. 4

	i	A1	B1	C1	D1	E1	F1	G1	H1	J1
R.	4,42	o		o		o		o	o	
1.G	4,42	o		o		o		o		o
2.G	3,05		o	o						o
3.G	2,10	o			o	o				o
4.G	1,45		o		o			o		o
5.G	1,0	o					o			
6.G	0,69		o			o	o	o		

FIG.5

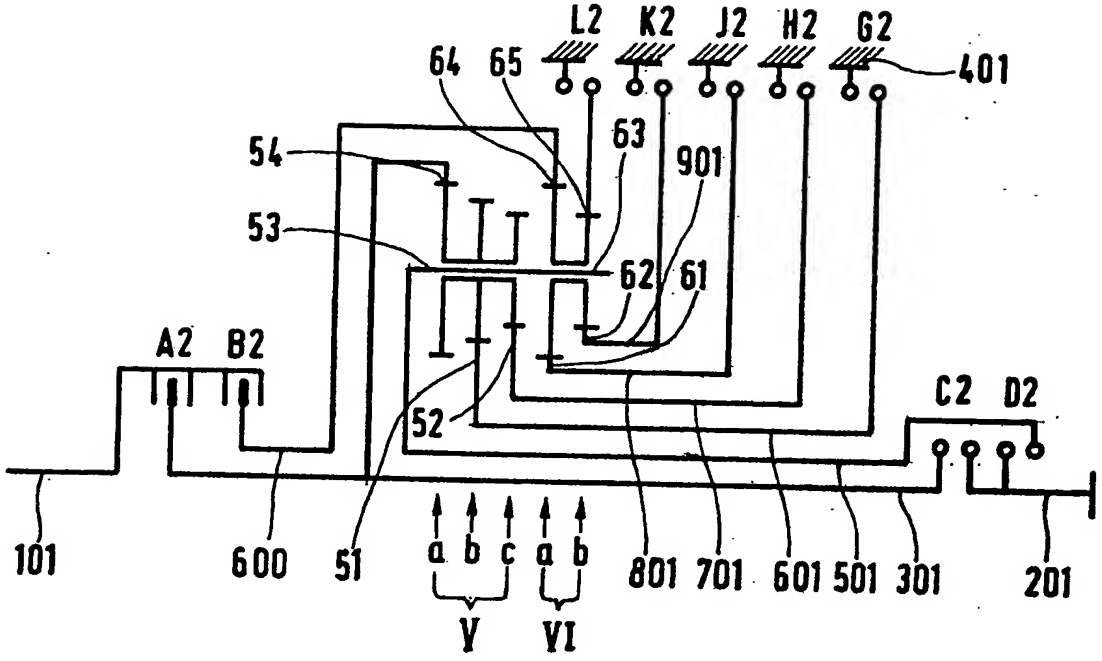

FIG.6

	i	A_2	B_2	C_2	D_2	G_2	H_2	J_2	K_2	L_2
R.			o		o					o
1.G	2,5	o			o		o			
2.G	2,0		o		o				o	
3.G	1,58	o			o	o				
4.G	1,26		o		o			o		
5.G	1,0	o		o						
6.G	0,79		o	o		o		o		

FIG. 7

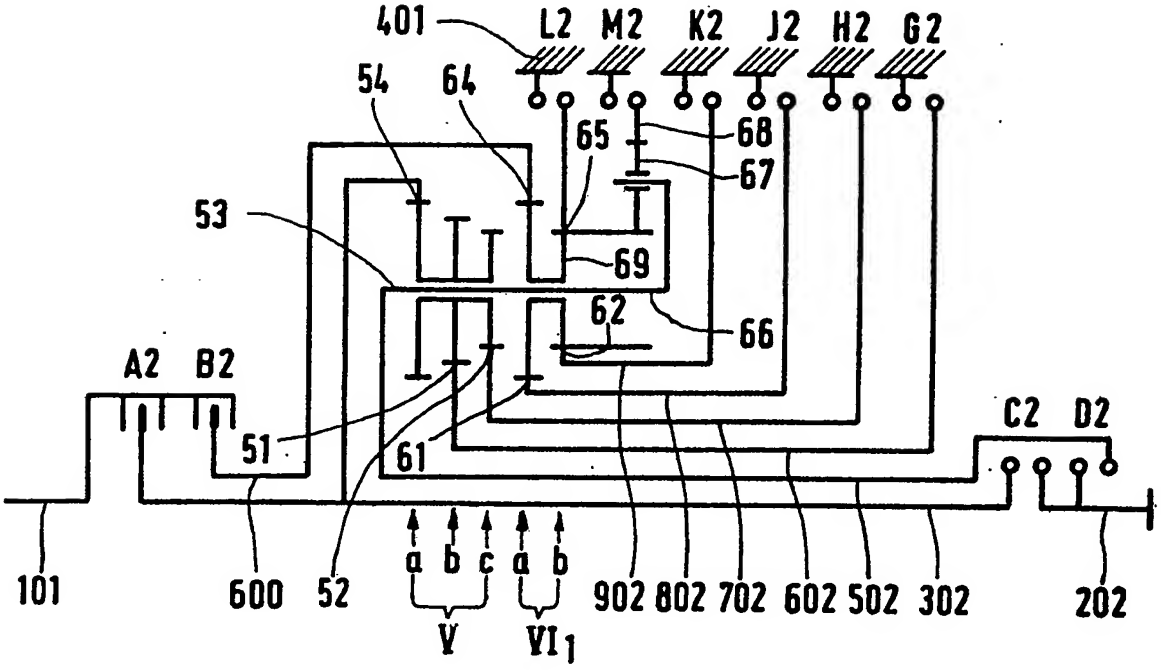

FIG. 8

	i	A_2	B_2	C_2	D_2	G_2	H_2	J_2	K_2	L_2	M_2
R.			o		o					o	
1.G	3,2		o		o						o
2.G	2,5	o			o		o				
3.G	2,0		o		o				o		
4.G	1,58	o			o	o					
5.G	1,26		o		o			o			
6.G	1,0	o		o							
7.G	0,79		o	o		o		o			

FIG.9

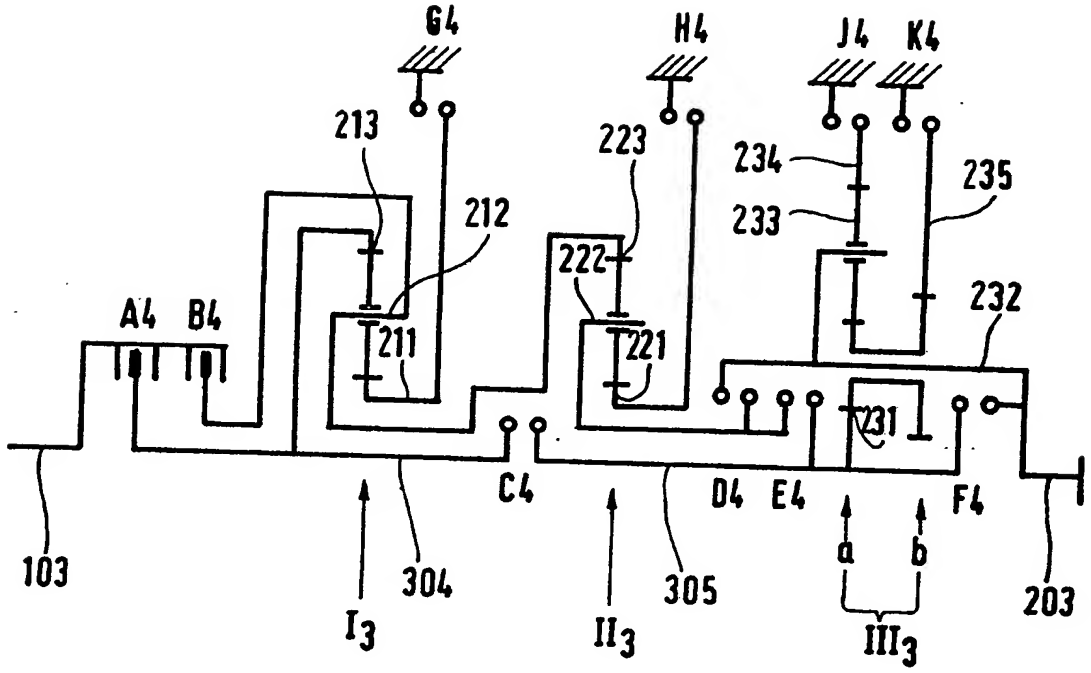

FIG.10

	i	A4	B4	C4	D4	E4	F4	G4	H4	J4	K4
R.	4,42	o				o		o	o	o	
1.G	4,42	o				o		o	o		o
2.G	3,05		o			o			o		o
3.G	2,10	o		o							o
4.G	1,45		o		o				o		
5.G	1,0	o		o			o				
6.G	0,69		o	o			o	o			

FIG. 11

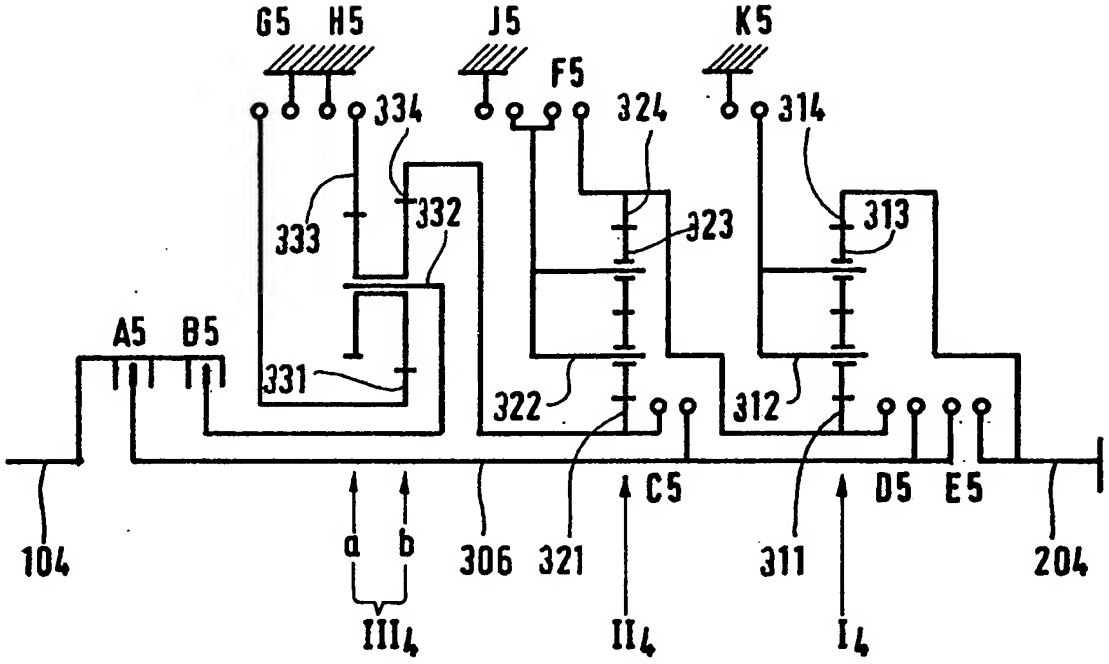

FIG. 12

	i	A5	B5	C5	D5	E5	F5	G5	H5	J5	K5
R.	4,42		o						o	o	o
1.G	4,42	o		o						o	o
2.G	3,05		o					o		o	o
3.G	2,10	o			o						o
4.G	1,45		o				o	o			o
5.G	1,0	o				o					
6.G	0,69		o	o		o		o			

SPECIFICATION.

Planetary change-speed gear unit shiftable under load

The present invention relates to planetary change-speed gear units shiftable under load and, in particular, but not exclusively, to such units for automatic operation in motor vehicles.

Planetary change-speed gear units shiftable under load are known and generally comprise several interconnected planetary gear sets with associated clutches and brakes. These known units (see, for example, German patent specification DE—PS 24 47 581) have proved satisfactory when only relatively few gear ratios are required. However, each additionally required gear involves considerable extra constructional cost not only in terms of the gear unit itself, but also in respect of the associated control system which has to be adapted to the different range of gearing ratios in order to attain good gear shifting, i.e. as non-jerky as possible, under all travelling conditions.

Figure 8 and 9 of the aforesaid German specification show a six speed gear unit of the kind under consideration which satisfies practical requirements relatively well, and includes a high speed forward gear. In this unit, only one clutch or brake is engaged or disengaged in shifting from one gear to another. However, despite the advantages offered by this gear unit in terms of constructional cost and gear shiftability, seven clutches and brakes are still necessary to engage all the gears and these clutches and brakes have to be matched to each other for automatic shifting.

The object of the invention is therefore to provide a planetary change-speed gear unit shiftable under load which is of reduced constructional cost in terms of the overall gear unit and the gear control system, when measured in terms of the gearing range which can be attained and utilised in practice.

According to the present invention, there is provided a planetary change-speed gear unit shiftable under load and comprising input and output shafts, a plurality of planetary gear sets, two first clutches capable of actuation under load, and a plurality of brakes and second clutches selectively engageable in different combinations each corresponding to a different gear setting of the gear unit and establishing a respective drive line from the input shaft to the output shaft via a said first clutch and components of said gear sets, the arrangement being such that, in use of the gear unit, the two said first clutches are engageable alternately to shift the gear unit in order through a range of said gear settings in each of which:

a) the operative drive line through the unit is established by engaged ones of said second clutches and brakes and passes through the engaged first clutch, and

b) the brakes and second clutches needing to be engaged for the gear setting next required, can be engaged in an unloaded condition whilst drive is being transmitted through said operative drive line, the said gear setting next required being subsequently engaged by reversing the state of engagement of the first clutches,

one or more of the gear sets being operative not only in at least one drive line passing through one said first clutch but also in at least one drive line passing through the other said first clutch.

Due to this arrangement only two components of the gear units, namely the two first clutches are required to be capable of actuation under load. This leads to considerable simplification, not only in the gear unit itself but in particular in the gear-unit control system, because the matching requirement during gear shifting can be limited to the two first clutches.

Various forms of planetary gear set can be used in the gear unit including standard single-stage gear sets (comprising a sun wheel, planets carried on a planet carrier, and a ring gear) and multiple-stage stepped gear sets in which the planet-carrier of the gear set carries stepped planet wheels each of which provides a number of rigidly-interconnected, differently-sized, planets respectively associated with a corresponding one of the gear stages of the gear set. In such multiple-stage stepped gear sets, the ring gear or sun wheel of one or more stages may not be required for the gearing configuration employed in which case this element is omitted. The gear sets can also be of the form in which intermediate wheels are provided on the planet carrier and are operatively interposed between the planets and ring gear of a gear stage.

More particularly, in one embodiment of the present invention, the gear unit comprises two single-stage and one two-stage planetary gear sets, one of the single-stage gear sets serving simply as a gearing constant in the drive line from one of the first clutches and the other single-stage gear set having a planet carrier in common with the two-stage gear set.

In another embodiment of the invention, the gear unit has only one single-stage planetary gear set and one three-stage stepped planetary gear set.

In a further embodiment of the invention, the gear unit has both a three-stage and a two-stage stepped planetary gear set, these sets being formed with a common planet carrier so leading to relatively low constructional cost. By axially-extending the toothing of the second-stage planets of the two-stage stepped planetary gear set and arranging for these planets to engage, via intermediate gear wheels, a second ring gear associated with this second-stage, an additional gear setting can be obtained, thus providing a gear unit with extremely satisfactory gear ratios.

Although the two first clutches capable of actuation under load can be spaced within the gear unit (e.g. one at the input and one at the output of the gear unit), it is advantageous if these clutches are both disposed at the input shaft since they will then be subject to lower moments which

enables their size to be minimised.

It should be noted that although German Patent Specification DE—PS 883 691 describes a change-speed gear unit comprising two independent clutches, these transmit the drive torque alternately from an input shaft to an output shaft by way of respective preliminary shafts.

Change-speed gear units embodying the invention will now be particularly described, by way of example, with reference to the accompanying diagrammatic drawings, in which:

Figures 1, 3, 5, 7, 9 and 11 are gear diagrams of first, second, third, fourth, fifth and sixth change-speed gear units embodying the invention; and

Figures 2, 4, 6, 8, 10 and 12 are tabulations showing, for the gear units of Figures 1, 3, 5, 7, 9 and 11 respectively, the various clutches and brakes which are engaged in each gear position and the corresponding overall transmission ratio attained.

The planetary change-speed gear units illustrated in Figures 1, 3, 5, 7, 9 and 11 all have in common the fact that they are provided with two clutches A and B which can be engaged and disengaged under load and operate alternately as the gear unit is shifted through at least its forward gears, the clutches A and B being associated with an input shaft 1, 100 to 104 of the gear unit and serving to transmit the drive torque alternately by way of a respective drive line to the gear-unit output shaft 2, 200 to 204. The gear units to be described are also provided with further clutches, e.g. C to F, and with brakes G to K, to enable different forward gear ratios to be set and also to allow shifting into the reverse gear position, the overall arrangement of each of the gear units being such that these further clutches and brakes can be actuated to set up the next gear required when unloaded. Thus while one of the clutches A, B is engaged and the associated drive line transmits the torque, it is possible to selectively actuate the further clutches and brakes such as to set the unloaded drive line (associated with the disengaged clutch B, A) ready for the next desired gear shift. There is thus more time to bring about any required synchronisation, so that the risk of overloading synchroniser devices is reduced. The problem of smoothly transferring the load being transmitted by the unit from one gear ratio to another gear ratio under the control of the gear unit control system is thus limited to the two clutches A and B, thus leading to considerable simplification. If the two clutches A and B are, for example disposed adjacent each other in the region of the input shaft, this leads to further advantages in respect of their operability and also in the respect of the control system in relation to any required synchronisation.

In the change-speed gear unit illustrated in Figure 1, planetary gear sets are disposed between the output shaft 2 and the clutches A, B associated with the input shaft 1, in the following sequence:

i) a single-stage planetary gear set I comprising a ring gear wheel 13 and associated brake J, a planet carrier 12 connected to the output shaft 2 and carrying planets (not referenced), and a sun wheel 11 connected by an inner central shaft 3 both to the clutch A and to a clutch C;

ii) a two-stage stepped planetary gear set II comprising a planet carrier 22 carrying stepped planet wheels (not referenced) each of which provides a pair of rigidly-interconnected planets respectively associated with the first and second stages IIa, IIb of the gear set II, the carrier 22 being connected both to the planet carrier 12 of the first planetary gear set I and to the clutch E, a sun wheel 21 associated with the first gear stage IIa and connected both to the clutch C and to the clutch D, ring gear wheels 24, 25 with associated brakes G, H, and intermediate wheels 23 disposed in the first gear stage IIa intermediate the planets and ring gear wheel 24 of this stage; and

iii) a single-stage planetary gear set III comprising a sun wheel 31 rigidly connected to the gear unit casing 4, a ring gear 33 connected to the clutch B, and a planet carrier 32 with associated planets. The carrier 32 is connected to the afore-mentioned clutches E and D.

The Figure 2 Table indicates which of the clutches A to E and brakes G to J are engaged for each of the seven possible gear settings of the Figure 1 unit, these settings being one reverse gear R and six forward gears 1.G to 6.G. The gear ratios for each gear setting are given in the column headed "i" of the Figure 2 Table.

It can be seen from the Figure 2 Table, that for the forward gear settings, the two clutches A and B capable of actuation under load are alternately engaged as the gear unit is shifted up and down the gears. It is also apparent which preparatory shifting operations have to be carried out in the unloaded drive line associated with the disengaged clutch A or B in order to set up this line for the near required gear.

The form of the Figure 1 gear unit is particularly advantageous in that it enables six forward and one reverse gear to be attained using only two single-stage planetary gear sets I, III and one two-stage stepped planetary gear set II with intermediate gear wheels, together with three respective clutches C, D, E and brakes G, H, I, the highest gear setting being a direct-coupled gear and a very high step-down ratio being possible in the first and reverse gears. A further advantage of the Figure 1 unit is that the single-stage planetary gear set III disposed in the vicinity of the input shaft does not have to be engaged and disengaged.

The planetary change-speed gear unit illustrated in Figure 3 has an input shaft 100 connected to the two clutches A1, B1 capable of actuation under load. Downstream of the clutches A1, B1 is a single-stage planetary gear set I_1, which is driven by the clutch B1 by way of the planet carrier 121 of this gear set, the planet carrier being also connected to a clutch C1. The sun wheel 111 and ring gear 131 of the gear set I_1 are respectively connected to a brake G1 and to a

hollow shaft 500 on which clutches D1 and E1 are disposed. The shaft 500 coaxially surrounds a shaft 300 coming from the clutch A1; this shaft 300 is also connected to the clutch E1, and carries a clutch F1. A three-stage stepped planetary gear set IV is arranged between the first, single-stage, planetary gear set I_1 and the output shaft 200 of the gear unit. The three-stage gear set IV has a planet carrier 43 which carries a set of planet wheels each of which provides three rigidly-interconnected planets respectively associated with the first, second and third stages IVa, IVb, IVc of the gear set IV. In addition, the first gear stage IVa has intermediate gear wheels 44, the first and third stages IVa and IVc have respective ring gears 45, 46 with associated brakes H1 and J1, and the first and second stages IVa and IVb have sun wheels 41 and 42. The planet carrier 43 is connected to the output shaft 200, and this latter is also connected to a clutch F1. The sun wheel 41 of the first gear stage IVa is connected to the clutch C1, and the sun wheel 42 of the second gear stage IVb is connected to the clutch D1.

Figure 4 shows, for each gear-setting of the Figure 3 unit, which of the various clutches and brakes of the unit are engaged and the corresponding gearing ratio.

The planetary change-speed gear unit of Figure 5 has an input shaft 101 connected to the two clutches A2, B2 capable of actuation under load. Downstream of the clutches A2, B2 is a three-stage stepped planetary gear set V and a two-stage stepped planetary gear set VI with a common planet carrier 53/63 which is connected by way of a hollow shaft 501 and clutch D2 to the output shaft 201 of the unit. The three-stage stepped planetary gear set is also connected by way of the ring gear 54 of its first gear stage Va to an inner shaft 301, which is also connected to the clutch A2 and to a clutch C2. The clutch C2 is additionally connected to the output shaft 201. The sun wheels 51, 52 of the second and third gear stages Vb and Vc of the gear set V are respectively connected by way of hollow shafts 601 and 701 coaxial with the shaft 301, to brakes G2 and H2. The sun wheels 61 and 62 of the two-stage planetary gear set V1 are connected to brakes J2 and K2 by way of hollow shafts 801 and 901 which coaxially surround the shafts 301, 501, 601 and 701. The ring gear 64 of the first gear stage VIa of the gear set VI is connected to the clutch B2, and the ring gear 65 of the second gear stage VIb is connected to a brake L2.

Figures 6 and 8 show for each gear setting of the gear units of Figures 5 and 7 respectively, which of the various clutches and brakes of the unit are engaged and the corresponding gearing ratio.

The gear unit of Figure 7 differs from that of Figure 5 only in that the second stage of the two-stage stepped planetary gear set is a compound stage, the toothing of the planets 69 of this second gear stage being extended to enable this gear set to be additionally provided with intermediate gear wheels 67 in mesh both with the planets 69 and with a further second-stage ring gear 68 associated with a brake M2.

The planetary change-speed gear unit of Figure 9 has an input shaft 103 connected to the two clutches A4, B4 capable of actuation under load. Downstream of the clutches A4, B4 are two single stage planetary gear sets I_3 and II_3, and one two-stage stepped planetary gear set III_3 with intermediate gear wheels 233 in its first gear stage III_3a. The sun wheel 211 of the first single-stage planetary gear set I_3 is connected to a brake G4, while the corresponding ring gear 213 is connected to an inner shaft 304, connected to the clutch A4 and a clutch C4. The planet carrier 212 of the gear set I_3 is connected to the clutch B4 and to the ring gear 223 of the second single-stage planetary gear set II_3. The sun wheel 221 of the second single-stage planetary gear set is connected to a brake H4, and the planet carrier 222 of this gear set is connected by way of a clutch D4 to the planet carrier 232 of the two-stage stepped planetary gear set III_3. The planet carrier 222 of the second single-stage planetary gear set II_3 is also connected by way of a clutch E4 to an inner shaft 305, coaxially aligned with the shaft 304. The shaft 305 is connected to the sun wheel 231 of the first gear stage of the two-stage stepped planetary gear set. A clutch F4 is interposed between the inner shaft 305 and the output shaft 203. The planet carrier 232 of the two-stage stepped planetary gear set III_3 is directly connected to the output shaft 203. In addition to the sun wheel 231, the two-stage planetary gear set comprises stepped planet wheels (not referenced), intermediate wheels 233 meshing with the first-stage planet portions of the planet wheels, and ring gears 234, 235 with associated brakes J4 and K4.

Figure 10 shows for each gear setting of the Figure 9 unit, which of the various clutches and brakes of the unit are engaged and the corresponding gearing ratio.

The planetary change-speed gear unit of Figure 11 has an input shaft 204 connected to the two clutches A5, B5 capable of actuation under load. Downstream of the clutches A5, B5 is a two-stage stepped planetary gear set III_4 and two single-stage planetary gear sets II_4 and I_4 with intermediate gear wheels 313 and 323. The ring gear 333 of the first stage III_4b of the gear set III_4 is connected to a brake H5 while the planet carrier 332 of the gear set III_4 is connected to the clutch B5. The sun wheel 331 and ring gear 334 of the second gear stage III_4b of the gear set III_4 are respectively connected to a brake G5 and to the sun wheel 321 of the single-stage planetary gear set II_4. The ring gear 334 is also connected to the clutch C5 which in turn, is also connected by way of an inner shaft 306 to the clutch A5 and to clutches D5 and E5. The clutch E5 is connected to the output shaft 294 as is the ring gear 314 of the planetary gear set I_4. The clutch D5 is also connected to the sun wheel 311 of the planetary gear set I_4, to the ring gear 324 of the planetary gear set II_4, and to a clutch F5 operable to provide

a connection to the planet carrier 322 of the gear set II_4. The planet gear carrier 322 is connected to a brake J5, and the planet carrier 312 of the planetary gear set I_4 is connected to a brake K5.

Figure 12 shows for each gear setting of the Figure 11 unit, which of the various clutches and brakes of the unit are engaged and the corresponding gearing ratio.

From the foregoing, it is apparent that for all the illustrated gear units, the two clutches A, B capable of actuation under load are alternately engaged as the gear unit is shifted through the forward gears, the drive line for the gear next to be engaged being set up by actuation of unloaded brakes and clutches and this line being subsequently engaged by engagement of the previously-disengaged one of the clutches A, B while the previously engaged one of the clutch B, A is disengaged.

The gear units of Figures 5 and 7 are particularly satisfactory with respect to their high speed gear settings — gear 6G of Figure 6 and gear 7G of Figure 8. Although in both embodiments the torque is transmitted from the input shaft 101 by way of the clutch B2 and the hollow shaft 600 to the ring gear 64 of the first gear stage VIa of the two-stage stepped planetary gear set VI, the output is not taken from the planet carrier as in the normal manner, but from the ring gear 54 of the first gear stage of the three-stage planetary gear set V, and from there by way of the radially innermost shaft 301 or 302, which is also connected to the clutch A2, to the output shaft 201 or 202. The two-stage stepped planetary gear set VI is partially locked by the brake J2 by way of the sun wheel 61 of the first gear wheel train VIa, whereas the three-stage stepped planetary gear set V is partially locked by the brake G2 by way of the sun wheel 51 of its second gear stage Vb.

It is to be noted that this high speed gear setting is attained without any additional constructional cost, because the necessary clutches etc. are already required for attaining the other gear settings.

Various modifications to the illustrated gear units are, of course, possible. Thus, for example, it is possible to additionally fit these gear units with a torque converter, or the clutches A, B capable of actuation under load can be disposed at various spaced positions in the gear unit.

CLAIMS

1. A planetary change-speed gear unit shiftable under load and comprising input and output shafts, a plurality of planetary gear sets, two first clutches capable of actuation under load, and a plurality of brakes and second clutches selectively engageable in different combinations each corresponding to a different gear setting of the gear unit and establishing a respective drive line from the input shaft to the output shaft via a said first clutch and components of said gear sets, the arrangement being such that, in use of the gear unit, the two said first clutches are engageable alternately to shift the gear unit in order through a range of said gear settings in each of which:

a) the operative drive line through the unit is established by engaged ones of said second clutches and brakes and passes through the engaged first clutch, and

b) the brakes and second clutches needing to be engaged for the gear setting next required, can be engaged in an unloaded condition whilst drive is being transmitted through said operative drive line, the said gear setting next required being subsequently engaged by reversing the state of engagement of the first clutches,

one or more of the gear sets being operative not only in at least one drive line passing through one said first clutch but also in at least one drive line passing through the other said first clutch.

2. A planetary change-speed gear unit according to Claim 1, wherein the second clutches and brakes are selectively engageable in combinations corresponding to a plurality of the forward gear settings and at least one reverse gear setting.

3. A planetary change-speed gear unit according to Claim 2 wherein three said brakes and three said second clutches are provided, and wherein said plurality of gear sets comprises two single-stage planetary gear sets and a two-stage stepped planetary gear set with intermediate gear wheels in its first stage and a second stage formed by planets and a ring gear, the gear unit components being arranged as follows:

— one said first clutch is interposed between the input shaft and an inner shaft of the unit while the other first clutch is interposed between the input shaft and the ring gear of a first one of said single-stage planetary gear sets,

— the said first single-stage planetary gear set is connected by its sun wheel to a casing of the gear unit, first and second ones of said second clutches being interposed between the planet carrier of the first single-stage gear set and the first-stage sun wheel and the planet carrier respectively of said two-stage stepped gear set,

— the second single-stage planetary gear set is connected by its ring gear to a first one of said brakes, by its sun wheel to said inner shaft, and by its planet carrier to the planet carrier of the stepped planetary gear set and to the output shaft of the unit,

— the two-stage stepped planetary gear set is connected by its first and second-stage ring gears to second and third ones of said brakes respectively, the third one of said second clutches being interposed between the first-stage sun wheel of the two-stage gear set and said inner shaft.

4. A planetary change-speed gear unit according to Claim 2, wherein three said brakes and four said second clutches are provided, and wherein said plurality of gear sets comprises a single-stage planetary gear set and a three-stage stepped planetary gear set with intermediate gear wheels in its first stage, a second stage formed by planets and a sun wheel, and a third stage formed

by planets and a ring gear, the gear unit components being arranged as follows:

— one said first clutch is interposed between the input shaft and an inner shaft of the unit while the other said first clutch is interposed between the input shaft and the planet carrier of the single-stage planetary gear set,

— the single-stage planetary gear set is connected by its sun wheel to a first one of said brakes, with first, second, and third ones of said second clutches being interposed respectively between the planet carrier of the single stage gear set and the first-stage sun wheel of the three-stage gear set, between the ring gear of the single-stage gear set and the second-stage sun wheel of the three-stage gear set, and between the ring gear of the single-stage gear set and the inner shaft,

— the three-stage stepped planetary gear set is connected by its first and third stage ring gears to second and third ones of said brakes respectively, and by its planet carrier, which is common to all stages, to the gear unit output shaft, the fourth one of the second clutches being interposed between the said inner shaft and the output shaft.

5. A planetary change-speed gear unit according to Claim 2, wherein five said brakes and two said second clutches are provided, and wherein said plurality of gear sets comprises a two-stage stepped planetary gear set, and a three-stage planetary gear set with a first stage formed by planets and a ring gear and second and third stages each formed by planets and a sun wheel, the two-stage and three-stage gear sets having a common planet carrier and the components of the gear unit being arranged as follows:

— one said first clutch is interposed between the input shaft and an inner shaft of the gear unit while the other said first clutch is interposed between the input shaft and the first-stage ring gear of the two-stage gear set, a first one of said second clutches being interposed between said inner shaft and the output shaft,

— the three-stage stepped planetary gear set is connected by its first-stage ring gear to said inner shaft, by its second-stage sun wheel to a first one of said brakes, and by its third-stage sun wheel to a second one of said brakes,

— the two-stage stepped planetary gear set is connected by its first and second-stage sun wheels to third and fourth ones of said brakes respectively, and by its second-stage ring gear to the fifth one of said brakes, and

— the second one of said second clutches is interposed between the common planet carrier of the two stepped planetary gear sets and the output shaft.

6. A planetary change-speed gear unit according to Claim 2 wherein six said brakes and two second clutches are provided, and wherein said plurality of gear sets comprises a three-stage stepped planetary gear set with a first stage formed by planets and a ring gear and a second and a third stage each formed by planets and a sun wheel, and a two-stage stepped planetary gear set the second stage of which is a compound stage having a set of planets engaging not only a sun wheel and ring gear, but also intermediate gear wheels in mesh with a further ring gear, the two stepped planetary gear sets having a common planet carrier and the components of the gear unit being arranged as follows:

— one of said first clutches is interposed between the input shaft and an inner shaft of the unit while the other said first clutch is interposed between the input shaft and the first-stage ring gear of the two-stage stepped planetary gear set, a first one of said second clutches being interposed between the said inner shaft and the output shaft,

— the three-stage stepped planetary gear set is connected by its first-stage ring gear to the inner shaft, by its second-stage sun wheel to a first one of said brakes and by its third-stage sun wheel to a second one of said brakes,

— the two-stage stepped planetary gear set is connected by its first and second stage sun wheels to third and fourth ones of said brakes respectively, and by its two second-stage ring gears to fifth and sixth ones of said brakes respectively,

— the second one of said second clutches is interposed between the common planet carrier of the two stepped planetary gear sets and the output shaft.

7. A planetary change-speed gear unit according to Claim 2, wherein four said brakes and four second clutches are provided, and wherein the said plurality of planetary gear sets comprises two single-stage planetary gear sets and one two-stage stepped planetary gear set with intermediate gear wheels in its first stage and a second stage formed by planets and a ring gear, the components of the gear unit being arranged as follows:

— one said first clutch is interposed between the input shaft and a first inner shaft of the unit while the other said first clutch is interposed between the input shaft and the planet carrier of a first one of said single-stage gear sets, this latter planet carrier being connected to the ring gear of the second one of said single-stage gear sets, and a first one of said second clutches being interposed between the first inner shaft and a second inner shaft in coaxial alignment with said first inner shaft,

— the first single-stage planetary gear set is connected by its ring gear to the first inner shaft and by its sun wheel to a first one of said brakes,

— the second single-stage planetary gear set is connected by its sun wheel to a second one of said brakes, and by its planet carrier to the second inner shaft with the interposition of a second one of said second clutches,

— the two-stage stepped planetary gear set is connected by its first-stage sun wheel to the second inner shaft, by its first and second-stage ring gears to third and fourth ones of said brakes respectively, and by its planet carrier to the output shaft, third and fourth ones of said second

clutches being interposed respectively between the second inner shaft and the output shaft and between the planet carrier of the two-stage gear set and the planet carrier of the second single-stage gear set.

8. A planetary change-speed gear unit according to Claim 2, wherein four said brakes and four second clutches are provided, and wherein said plurality of gear sets comprises two single-stage planetary gear sets each with intermediate gear wheels, and one two-stage stepped planetary gear set with a first stage formed by planets and a ring gear, the components of the gear unit being arranged as follows:

— one said first clutch is interposed between the input shaft and an inner shaft of the unit while the other said first clutch is interposed between the input shaft and the planet carrier of the two-stage stepped gear set; first, second and third ones of said second clutches being interposed respectively between the inner shaft and the sun wheel of a first one of said single stage gear sets, between the inner shaft and the sun wheel of the second one of said single stage gear sets, and between the inner shaft and the output shaft,

— the two-stage stepped planetary gear set is connected by its first-stage ring gear to a first one of said brakes, by its second-stage sun wheel to a second one of said brakes, and by its second-stage ring gear to the sun wheel of the first single-stage gear set,

— the first single-stage planetary gear set is connected by its planet carrier to a third one of said brakes, and by its ring gear to the sun wheel of the second single-stage gear set, a fourth one of said second clutches being interposed between the ring gear and planet-carrier of the first single-stage gear set,

— the second single-stage planetary gear set is connected by its planet carrier to a fourth one of said brakes, and by its ring gear to the output shaft.

9. A planetary change-speed gear unit according to any one of the preceding claims, wherein the two first clutches are in the form of a single unit and lie adjacent to each other in an axial or radial direction.

10. A planetary change-speed gear unit according to any one of the preceding claims, wherein the two first clutches are physically disposed at the drive unit end of the gear unit.

11. A planetary change-speed gear unit according to Claim 5 or Claim 6, in combination with a control system for operating said clutches and brakes, wherein the control system is operative to provide a high-speed gear setting by effecting engagement of said first and third brakes, the first one of said second clutches, and the said other first clutch whereby to establish a drive line between the input and output shafts in a said other first clutch, the first-stage ring gear of the two-stage planetary gear set, the common planet carrier the first-stage ring gear of the three-stage planetary gear set, the said inner shaft, and the first one of said second clutches.

12. A planetary change-speed gear unit substantially as hereinbefore described with reference to Figures 1 and 2, 3 and 4, 5 and 6, 7 and 8, 9 and 10, or 11 and 12 of the accompanying drawings.

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